E C S

Electronic Components and Systems

ECS-SRA Long Term Vision

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Goal

Electronic Components and Systems

The objective is to identify the research subjects (now at low TRL) that need to be addressed in order to enable the realisation of the European industrial roadmap in the medium (5–10 years) and long term (>10 years)

3 time periods

- **Short term (2021–2025):** The industry has a precise idea of what will be achieved during that timeframe
- **Medium term (2026–2030):** There is still reasonably good knowledge of what can possibly be achieved.
- **Long term (2031 and beyond):** Expected achievements are more of a prospective nature

SRIA structure (Model)

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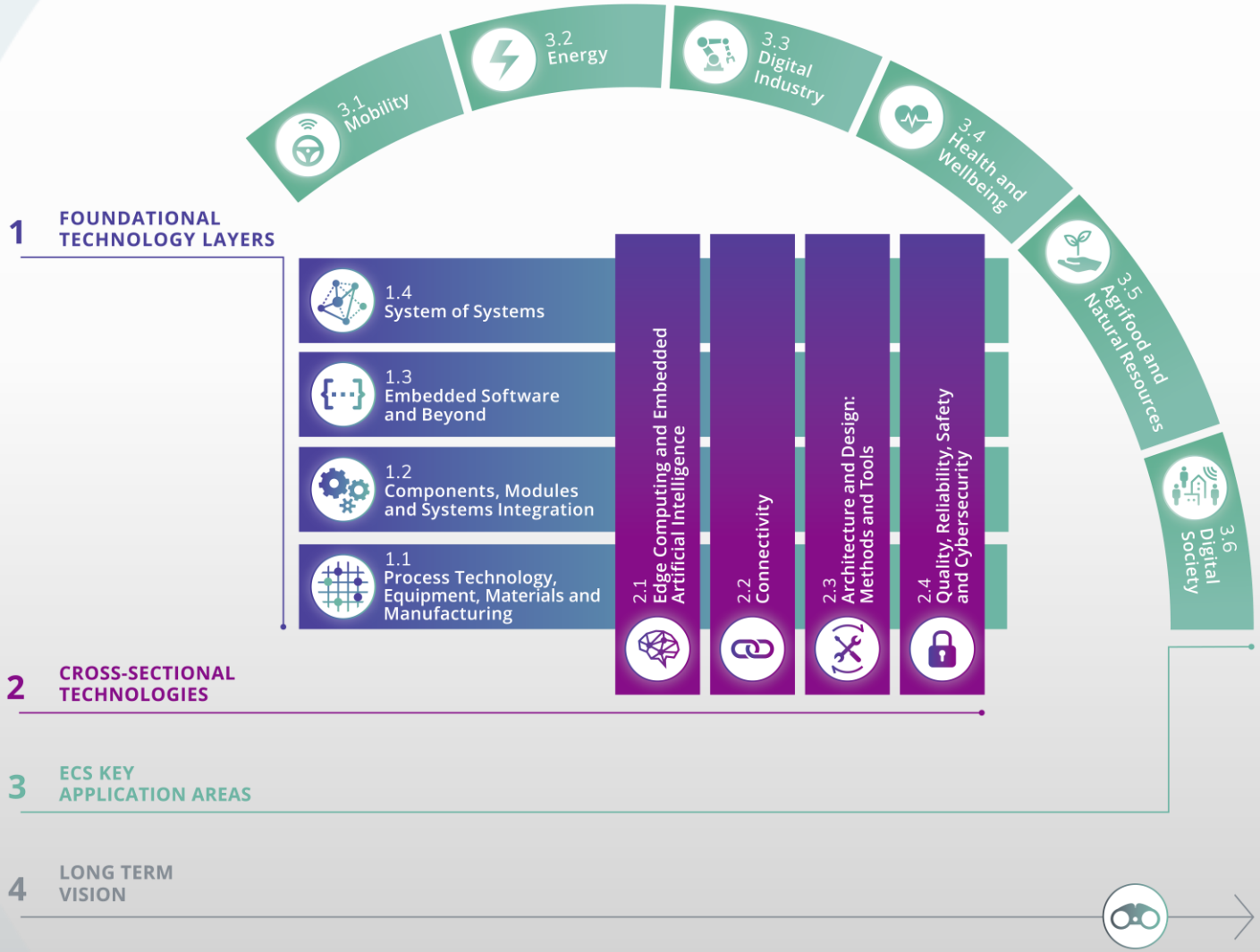

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GLOBAL TIMELINE: MEDIUM TERM 2026–2030

- Evolvable, predictable and controllable composition of functional and extra-functional properties of System-of-systems.
- Compilers and link to new hardware
- Interface management to prepare for System-of-systems integration
- Embedded software enabling systems to dynamically (re)-configure after updates or changes in the environment
- Maturity model for robustness of embedded software
- Energy management towards low/zero power
- Heterogeneous integration for harsh environments
- Organic, compostable and biodegradable materials
- In-memory computing
- PCRAM
- 6G connectivity RF & photonics devices
- Smart GaN power devices
- Equipment for 1 nm node nanowire, nanosheet-based logic and memory

- Holistic development environment and semi-automatic HW/SW codesign exploration flow and tools
- Decentralised architectures and federated learning for high performance selected applications
- End-to-end AI-based embedded systems security by design

- Interoperability: General translation of payload information enabling application information usage

- Continuous development processes incl. automated data-flow, based on digital twins and KI-based data analysis
- Data-collection at run-time in fail-operational CPS
- Online V&V, safe and secure deployment, supported by modular and evolvable/ extendable reference architectures and platforms

- Certification strategy under uncertain & dynamically changing environment
- New self-learning methods to ensure safe operations of complex systems
- SW & HW reliability metrics
- Digital twin as enabler to monitor ECS

- Automated mobility in specific areas
- Validation procedure for automated vehicles
- Fuel cell passenger car and light-weight mobility
- Energy-optimised rural mobility systems

- Pilot of advanced human–machine joint intelligence
- Deeper integration of service-provider to end-user industrial processes

- Storage devices providing flexibility, stability and reliability in the grids
- Local DC-coupling of various technologies for fast charging at home
- Further energy efficiency improvements

- Next generation (patch-like) drug delivery systems part of the Internet of Medical Things
- Precision diagnosis to prevent hospital readmission

- Food traceability over the whole value chain
- Improved electrochemical sensors for natural resources quality monitoring

- Improved human–machine interfaces
- Time-critical functions moved to cloud
- Multimodal and multi-sensory interfaces in serious gaming (beyond single games)

GLOBAL TIMELINE: LONG TERM 2031 AND BEYOND

- Policy based autonomous System-of-systems engineering and evolution
- Programming languages to develop large scale applications for embedded System-of-systems
- Embedded software for trusted (secure and safe) autonomous systems
- Convergence of sensing principles
- Integration methods for quantum computing, communication and sensing
- Zero defect manufacturing and circular economy for ECS
- Gallium oxide and/or diamond-based power devices
- Equipment for sub-1nm node for logic and memory including 3D monolithic integration
- Novel computing paradigm concepts (optical/quantum) including packaging platforms

- Integration and orchestration of multiple computing paradigms into AI-based embedded systems
- Global reconfiguration of resources to satisfy functional and non-functional requirements
- Certifiable and explainable AI

- Autonomous interoperability: from physical layer to instant information understanding

- Certification at run-time (for known environments and for restricted classes of updates)
- AI-based design processes and tools
- Architectures and tools for new technologies, e.g. non von-Neumann, neuromorphic computing, quantum technologies

- EU ecosystems for dependable SW
- Digital literacy curricula to achieve high levels of AI knowledge and competences
- AI/ML enable to shorten development cycle and deploy PHM for the ECS's

- Fully automated mobility
- True multimodal mobility
- Approach to CO_2-neutral (from cradle to grave) mobility

- Life cycle assessment as integral part of design-time and operative decision-making

- Close to zero emission (due 2050):
- Emission free cities with electrification, renewable energy sources and decentralised storages to improve reliability and efficiency (energy distribution, storage, and usage)

- Organ-on-a-chip developments addressing rare diseases

- AI-powered robots ensuring plant health care
- Water distribution mgt. based on advanced IoT
- Reduction of cumulated carbon and cropland footprint by 20% in the next 20 years

- Trustable AI-based IoT systems for increased situational awareness in surveillance and emergency response support
- No bandwidth and QoS limitation for video applications
- Real-time emotion sensing

Motivation

Common objectives

Boost industrial competitiveness through interdisciplinary technology innovations

Ensure EU digital autonomy through secure, safe and reliable ECS supporting key European application domains

Establish and strengthen sustainable and resilient ECS value chains supporting the Green Deal

Unleash the full potential of intelligent and autonomous ECS-based systems for the European digital era

Technology long-term challenges/vision

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Process technology, equipment, materials and manufacturing

- Low power, new materials, ultimate processing technologies, nanodevice architectures, advanced sensors, nanowires, NCFETs, TFETs, low voltage NEMS-FET, CNT-FETs

Components, modules and systems integration

- Diverse component integration (fast, efficient, robust), accommodate flexible/stretchable substrates/components, electronic/photonic integration, self-powering and energy harvesting, modelling and simulation, charactetization and reliability, tools (3D place-and-route)

Embedded software and beyond

- Testing (model-based, fuzzing), verification, software engineering, short development cycle, maintenance, lifecycle management, extensibility, composability, interoperability, digital twins, quantum computing, approximate computing

System of systems

- Distributed AI, connected and interacting domains, predictability controllability, monitoring, diagnosis, model-based engineering, automated and autonomous engineering, machine interpretable content

Technology long-term challenges/vision (2)

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Artificial intelligence, edge computing and advanced control

- Accelerators, low power, quantum computing, biocomputing, device manufacturing, dynamically configurable systems, system architecture/interface discovery, self-* systems, explainable AI, certifiable AI, AI-based embedded systems

Connectivity

- 5G/6G/..., dynamic configuration, SoS connectivity, virtual networks, dynamic networks, energy-efficiency

Architecture and design: methods and tools

- Hw/sw co-design, power-aware scheduling, AI/ML coprocessors, trusted platforms, ...

Quality, reliability, safety and cybersecurity

- Security/safety-by-design, runtime verification, security monitoring, model-checking methods, trusted platforms, ...

Application evolution and long-term challenges

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Mobility

- Electric mobility, H2-based mobility, synthetic fuel mobility, user-friendly secure and fast infrastructure, safe embedded software, software-enabled vehicles, IoV, vehicle component reliability/cost/safety, system complexity management, autonomous vehicles, mobility related sensors, reliable vehicle-to-cloud connectivity

Energy

- Energy generation/conversion/storage systems, flexible and reliable grids, HV transmission technologies, community/regional energy management, AI & cybersecurity for resilient energy systems, control and management of end-to-end systems

Digital industry

- Digital twins, continuous operation, runtime monitoring, life cycle assessment, predictive maintenance, advanced control, operative decision making, …

Health and wellbeing

- Healthcare cost reduction, improving well-being dagnoses and therapies, real-time local disease detection, personalized treatment (medicine, etc.), medical data security/safety/privacy, health digital twins, organ-on-chip, 3D-bioprinting, cyborgisation

Agrifood and natural resources

- Food security, food safety, environmental protection and sustainable production, water management systems, biodiversity enablement and management

Digital society

- Ubiquitous connectivity, inclusion, continuous ”online”

Conclusions

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Looking to the future

- Materials, structures, components, architectures, system software, applications
- AI, edge computing, advanced control, connectivity, quality, security, safety, reliability, methods and tools

Comprehensive approach

Strong feedback by team

Waiting for feedback from EFECS

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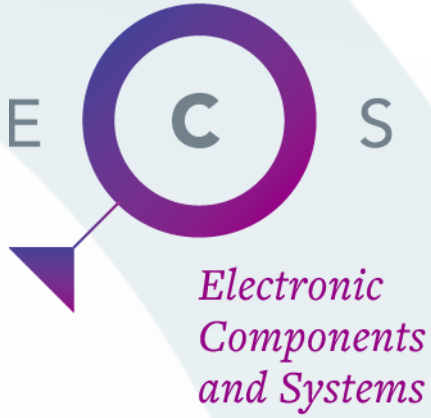

THANK YOU!